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WILDLAND FIRE PROTECTION AND PREPAREDNESS PLAN FOR PUNKHORN PARKLANDS BREWSTER, MASSACHUSETTS

PREPARED BY
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AND
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FOR
TOWN OF BREWSTER
AND
CAPE COD COOPERATIVE EXTENSION
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SITE INFORMATION

Site: Punkhorn Parklands **Total Acres:** 835
Town, County, State: Brewster, Barnstable Co., MA **Elevation:** 5 – 80 Feet
U.S.G.S. Quadrangles: Harwich and Dennis MA
Latitude: $41^0$43'27" N **Longitude:** $70^0$06'27" W
Ownership: Town of Brewster
Managed by: Brewster Conservation Commission and Brewster Water Department

General Description: This planning report encompasses the 835-acre Punkhorn Parklands. The Town of Brewster Conservation Commission and Water Department manage this area for conservation, water supply, and passive recreation.

The Punkhorn Parklands are primarily forested and support a network of trails and non-paved roads. The area is bounded on the east and west sides by large freshwater ponds, Figure 1. The ponds are often referred to as the "Noble Ponds of the Punkhorn", a dense collection of kettlehole ponds with good water quality. Several small ponds and shallow depressions are found within the interior of the property and support bog and shrub swamp. Privately owned commercial cranberry bogs are found outside the property near Elbow Pond and Hinckleys Pond. A small caretaker's cottage, known as the Mattot House, is owned and maintained by the Town of Brewster and occupied by Natural Resource staff during the summer months. Numerous small private inholdings are found within the Punkhorn Parklands, in the vicinity of Eagle Point Cartway, lower Westgate Road, and Archie's Cartway. The Brewster Water Department maintains the Greensand Water Treatment Facility and well sites east of Westgate Road.

Terrain is variable throughout the site. Soils are classified within the Carver, Plymouth-Barnstable-Nantucket, and Freetown general map units. Carver soils predominate under mixed oak and pine forests of the central and southern portion of the property. These deep and excessively drained sandy soils formed in glacial outwash deposits are nearly level throughout to moderately sloping around pond shores. The terrain becomes more hilly and bouldery within the northeast section, near Calf Field Pond. Sandy and loamy Plymouth-Barnstable-Nantucket soils predominate here, with mixed oak and pitch pine occurring more commonly with white pine and American beech. The Freetown coarse sand or Freetown mucky peat occurs in depressions, along streams, and in ponds and lakes.

Mixed oak species and pitch pine dominate forest vegetation within the Punkhorn Parklands. Various expressions of the vegetation reflect local site conditions such as slope, slope position, aspect, and past disturbance events. Understory vegetation is consistently shrubby, comprised of black huckleberry and lowbush blueberries, with scrub oak occurring to a lesser extent within the southwest portion of the property. Forest and woodland openings support several state uncommon wildflowers.

Ponds such as Seymour Pond, Walkers Pond, and Elbow Pond support rare plant communities, known as coastal plain pondshores. These shorelines provide habitat for several globally and state rare plants and animals. Punkhorn Parklands is also an important water recharge area for the Town of Brewster supporting active and future well sites managed by the Brewster Water Department.

Passive recreational uses include hiking, horseback riding, walking, nature observation, and swimming. The prominent land features, the extensive network of trails, and interesting vegetation make this open space area a pleasant place to hike, observe wildlife, and study the natural environments of Cape Cod.

EMERGENCY ASSISTANCE INFORMATION

Fire:	**Brewster Fire and Rescue** **Fire Chief:** Roy E. Jones III Headquarters 1657 Main Street Brewster, MA 02631	508 896-7018
	Harwich Fire Department **Fire Chief:** Wilfred Remillard Headquarters 175 Sisson Road Harwich, MA 02645	508 430-7546
Law Enforcement:	**Brewster Police Department** **Police Chief:** James R. Ehrhart 631 Harwich Road Brewster, MA 02631	508 896-7011
	Brewster Department of Natural Resources **Director:** Robert S. Mant 2198 Main Street Brewster, MA 02631	508 896-3701 ext.135
Medical:	**Brewster Fire and Rescue**	508 896-7018
	Cape Cod Hospital	508 771-1800
Site Managers:	**Brewster Conservation Administrator:** Keith Johnson 2198 Main Street Brewster, MA 02631	508 896 3701 ext.124
	Brewster Water Superintendent: Paul Hicks 1671 Main Street Brewster, MA 02631	508 896-5454
	Brewster Public Works Superintendent: Robert Bersin 201 Run Hill Road Brewster, MA 02631	508 896-3212

All emergency numbers can be reached through 911; the above numbers are direct lines.

JUSTIFICATION FOR MANAGEMENT

This Wildland Fire Protection and Preparedness Plan is funded through the Cape Cod Cooperative Extension in cooperation with the Town of Brewster, as part of a county-wide initiative to address wildfire hazards on town-owned or town administered open space tracts. The Town of Brewster nominated the Punkhorn Parklands as its highest priority for wildfire assessment and preparedness planning. It is Brewster's largest contiguous conservation property and consists of mixed oak and pitch pine forest, which contains highly flammable and heavy fuel accumulations. Residential development has increased within this interface area over the past two decades, warranting assessment of wildfire risks and hazardous fuels.

Punkhorn Parklands protects an extensive forested ecosystem interspersed with wetlands. This large extent of forestland provides important habitat for many wildlife species and enables residents and visitors to enjoy and learn about the natural world around them. The area serves many passive recreational functions and protects significant natural resources, as well as the scenic and natural character of forestland within Brewster. The area preserves important cultural and scenic resources and serves critical groundwater protection and well sites for the Town of Brewster.

Residential developments around the Punkhorn Parklands have expanded significantly over the past few decades. There are over 50 homes situated as either inholdings within the Punkhorn Parklands or within 100 feet of the Punkhorn's boundaries. This expanded development increases the potential for dangerous and costly wildfires to start in or near residential areas and then spread on to the Punkhorn or for wildfires to start in the Punkhorn and impact neighboring residential areas. National studies have shown that increased human activity within wildland settings generally increases the potential for wildfire ignitions. Managing this large area for its conservation and recreation values, reducing wildfire hazards, and protecting public safety are priorities for the Town of Brewster.

Prevention, detection, and suppression of wildfires should remain a very high priority for local fire control organizations, but resource managers must, at the same time, actively work to reduce heavy and highly flammable fuel loads in fire-prone areas through prescribed burning and mechanical cutting methods. Suppression alone will not eliminate the risk of wildfires. Although fires may occur less frequently, fires will eventually occur. Dependent on weather and fuel conditions, these fires can be expected to burn with intensities that may escape initial fire control and threaten human resources, both within the conservation area and on adjacent public and private property.

The only clear firebreaks within the property are water bodies and the existing gravel roads, neither of which are strategically located and adequate for fire protection. As a result of prevailing winds, most fires will spread from the south and west, to the north and east toward residential areas. Several residential areas are at risk. Adequate firebreaks and access for fire control are needed. Wider zones of reduced fuel loadings and increased access along certain boundaries and interior dirt roads could be achieved through a combination of mechanical treatment and prescribed fire with minimal soil disturbance. Fuel treatments are proposed to reduce the threat of wildfires. Prescribed burning – setting fires under identified conditions – can reduce fine fuels that spread wildfires. In certain areas, very high fuel loads and proximity to residential areas and major roads impose dangerous conditions for land managers to safely conduct prescribed burns and achieve ecological management goals. To address this problem, mechanical treatment such as mowing understory brush and selectively thinning trees may be used to reduce fuel loads and create conditions more favorable for continued

mechanical treatments or future prescribed burns. Thus reducing the risk of catastrophic wildfires, where heavy fuels, fuel ladders, and high winds spread fire into the forest canopy.

Several public agencies and conservation organizations on Cape Cod (including the National Park Service, Massachusetts Department of Fisheries, Wildlife, and Environmental Law Enforcement, Massachusetts Department of Conservation and Recreation, The Nature Conservancy, and Massachusetts Audubon Society) use a combination of prescribed fire and mechanical treatments to reduce hazardous fuel loads and maintain the ecological integrity of coastal plain forested ecosystems. Prescribed burns are carefully planned and executed to minimize escapes and smoke impacts, which are often a hazard associated with unplanned fires. Fire ecologists recommend burning designated fire-prone areas at regular periodic intervals. A program of periodic low to moderate intensity prescribed burns is designed to reduce accumulations of fine fuels and produce a long-term reduction in larger fuels.

It should be noted that although fire is a natural component of this forested ecosystem, the use of natural fire (e.g. non-management ignited fire) will not be allowed. Due to the close proximity of residential areas and transportation routes, all unplanned ignitions that occur within the Punkhorn Parklands will be aggressively suppressed using methods and means consistent with protecting lives and property.

FIRE HISTORY AND PAST LAND USES

Very small fire starts are relatively common within the Punkhorn Parklands. Fortunately, most fire starts have been quickly detected and suppressed or have gone out on their own due to moist weather conditions and precipitation. The majority of wildland fires occur in the spring before "green up", when the vegetation is dry and flammable. Reports of late summer wildfire do occur following periods of drought. The wildfire season usually begins in March and ends in late November. Lightning is rarely reported as the cause of wildfire on Cape Cod. Although, there is a record of a lightning caused wildfire reported from the Punkhorn Parklands. People are the likely cause of almost all fires. Some fires may be intentional arson fires. But most fires are accidental and may be started by homeowners burning brush, children playing in the woods with matches, someone carelessly dropping a cigarette, or even muffler sparks from a dirt bike or other off road vehicle ridden by young people on a hot, dry day.

Paleo-ecological records show that fire has been part of the Cape Cod landscape for thousands of years (Winkler 1985, Patterson and Sassman 1988, Stevens 1996, and Patterson 1999). In modern times, fire continues to influence the vegetation of Cape Cod to the extent that fire adapted natural communities predominate over most of the area. Cores taken from Duck Pond on Cape Cod National Seashore, dating back 12,000 years and 4,800 years respectively, found abundant charcoal throughout the stratigraphic column suggesting that fire has played an important role in maintaining pine and oak forests on the Cape throughout the Holocene (Winkler 1982 and 1985, Bachman 1984, Clark 2002, Patterson and Crary 2004). A sediment core taken by Patterson (1999) from Mary Dunn Pond in Barnstable supports the evidence that fire was an important influence within the pre and post European settlement landscape of Cape Cod.

Native Americans used fire as a landscape management tool to clear trails for travel, to hunt, to increase browse for game species, increase production of acorns and berries, and once agriculture was adopted, to clear and fertilize land. The ancient Saquatucket tribe lived, hunted, and fished within the Punkhorn at least as early as 8,000 years ago. They were drawn to this area, with its large ponds and ample fish stocks including alewives and blue-backed herring. The Saquatucket Tribe lived and roamed freely through forests and over pondshores of the Punkhorn throughout

the 1600's – hunting, farming, burning, cutting firewood, and fishing. The Punkhorn Parklands Trail Guide (19) reports the following:

> " …early colonists' records refer to the natives' "barns" (underground walled storage pits) and tar kilns (used to slow-boil pine sap). What is now Westgate Road was probably first a native foot trail linking the ponds and Harwich's Herring River to the south shore. The last Saquatucket died in 1818."
>
> "By 1716, the Europeans, known as Proprietors for First-Comers, laid out long, narrow, private lots for woodcutting. As the landscape was denuded, the open meadows were called the "Great Fields", which were used as a sheep common and community grazing area. Eastgate and Westgate Roads were named for boundaries of the pastures. By the late 1800's, a thriving cranberry industry developed on the Punkhorn Bogs. Near Calf Field Pond, granite boulders were quarried for use in making harbor jetties along the Bay."
>
> "Few people lived in the area as it was far from village life along the Cape's shores. In a 1747 deed, Proprietor John Dillingham referred to the locale as "Sepunkhorn", and gradually much of west Brewster's interior became known by locals as the "Punkhorn", perhaps meaning "a place of spongy wood".

The practice of firing the woods was continued by colonists until at least the late 1700's (Deyo 1890). Burning practices likely continued on forested lands during the time of settlement and farming. Wood was used to build and heat homes, supply local shipyards and businesses within the Factory Village, as well as supply salt making and charcoal iron industries elsewhere on Cape Cod.

By the early 1800's, almost all forested areas were divided into firewood lots and extensive fuelwood cutting and sheep grazing occurred on the landscape. Fires during this time were extensive, often thousands of acres. Descriptions of the Cape Cod landscape during this time, report widely spaced pitch pines and coppice oak sprouts. As the trail guide states, by the mid-1800's, most of the uplands within the Punkhorn were open grazing land and many of the Punkhorn's wetlands were utilized for cranberry production.

With the expansion of railroad activities on Cape Cod in the late 1800's, forest fires increased. Drifting embers from steam locomotives started most fires (Thompson 1928). During the early 1900's on Cape Cod, fires were abundant and Thompson (1928) reported an average of 8,500 acres of woodland burned annually. Tourism was becoming an important trade on Cape Cod by the early 1900's and public opinion began to favor the suppression of all fires, although some people still continued the practice of burning blueberry patches to increase berry yields.

The first fire tower on Cape Cod was erected in 1913 in the town of Barnstable to watch for fires and communicate fire locations to local fire fighters. The Massachusetts Department of Conservation and Recreation started patrolling the Cape in the 1920's along with local patrol trucks, which were equipped with water, hose, and tools. In the late 1930's, Cape Cod led the way in developing the first brush breakers to fight forest fires (Crosby 2003). After this period, forest fires tended to burn for shorter periods of time and consumed fewer acres.

Very large wildfires may still occur on Cape Cod every 30 to 50 years, instead of intervals of 10 to 20 years (Patterson and Ruffner 2002). Long intervals between fires may heighten the danger to the public, as fuels build up and people are prone to forget about the risk of wildfire and

become complacent about controlling flammable accumulations of fuels around dwellings and other structures.

THE FIRE ENVIRONMENT

Fires, like many natural events, are cyclic. The fire cycle is governed by conditions such as climate, storm events, insect outbreaks, topography, soils, existing vegetation, and human activities. The climate of Cape Cod is humid and continental characterized by a moderate to large annual temperature range and well-developed winter and summer seasons. Precipitation is ample in all months and favors development of forests (Strahler 1966). The vegetation exhibits a maritime influence due to its proximity to the Atlantic Ocean. Prevailing winds are out of the southwest from April through October and out of the northwest from November through March. Winds from the northeast are associated with storm events, bringing high winds, driving rain, and cold damp air. Precipitation maximums occur during the winter months and a minimum usually occurs in late May through July (Fletcher 1993).

Most wildfires are likely to occur in late spring and early summer, associated with southwesterly winds. The potential for fire is highest during periods of low precipitation and humidity, when fine fuels can ignite easily. Relative humidity levels are usually lowest in March through May. Wildfires occurring during periods of low humidity can create sparks and embers carried aloft in the rising hot air above the fire and cause spot fires downwind of the main fire. Strong northwesterly winds associated with changing frontal systems in early spring or fall flame many large and hard to suppress wildfires. In high winds, embers may be carried hundreds of feet from the main fire and cross barriers such as roads and water bodies.

The sandy soils found throughout the Punkhorn tend to dry quickly and create conditions ripe for severe fires during dry periods in the spring, summer and fall. Drought conditions in the summer can reduce live fuel moisture. Such conditions in the summer can also reduce moisture in soil and duff layers, so that the potential for severe fires increases (Patterson and Ruffner 2002).

The Keetch-Byram Drought Index (KBDI) is currently used in fire planning to evaluate the effects of extended drying on the duff layer. The index increases for each day without rain and the amount of increase depends on the daily high temperature. The scale ranges from 0 (no moisture deficit) to 800. A prolonged drought creates a high KBDI, making more fuel available for combustion and increased smoldering and difficulty in fire suppression. This mathematical system helps relate current and recent weather conditions to potential or expected fire behavior (Keetch and Byram 1988, Melton 1989). The National Park Service tracks the KBDI at Cape Cod National Seashore. This drought index is also calculated at various Massachusetts Department of Conservation and Recreation properties to help determine fire danger.

Major tropical storms occur every 30 to 40 years on Cape Cod and the islands (Foster and Boose 1995, Foster and Motzkin 1999). Salt exposure and intense wind events may damage vegetation. Pines are especially susceptible to windthrow, uprooting, crown and branch damage. Increased available fuels and the potential for more severe wildfires result from hurricanes and tropical storms. Cape Cod has a long history of severe winter storms, blizzards, and nor'easters. Most winter storms bring the Cape storm surges and high winds. The December 2005 storm brought very high winds and heavy snow to many areas of the Cape. Many trees, which were heavily weighted with snow were uprooted or damaged. Pitch pine and locust trees were most susceptible.

Periodic defoliation of trees (especially oaks) by forest insects such as the gypsy moth or the newly arrived winter moth increases the exposure of sunlight to understory fuels. Downed tree branches, fine fuels in the understory, and leaf litter tend to dry out more quickly. Prolonged hot and dry conditions during episodic insect outbreaks increase fire danger and the potential for fire starts. A small area of insect damage, less than one acre, was observed in a forested area east of Westgate Road, south of Seymour Pond Trail, and north of Massasoit Trail.

Topographic relief is variable within the Punkhorn. Throughout much of the site, terrain consists of flat to gently rolling sandy plains between ponds and small kettlehole depressions. Terrain becomes more variable and slope increases along the periphery of wetlands and pondshores (5-30%). The northeastern portion of the site is hilly and bouldery, with a maximum elevation of 80 feet above sea level and slopes up to 35%. Large boulders and variable terrain limit the use of brush breakers and other engines within the northeast portion of the property.

Topography is an important factor considered in fire management planning. Generally, fire will move up slope more rapidly and with greater intensity than it will move down slope. Fire moving up slope will preheat fuels, thereby increasing fire intensity and rates of spread. Fire intensity and rates of spread moving down slope behave much like backing fires on flat terrain. Topography can effect wind and cause local changes in fire direction, intensity, and rates of spread. Wind moving upslope may be diverted around a hill, resulting in a change in direction. On moving from flat ground to sloping ground, wind may eddy and become turbulent, resulting in updrafts and downdrafts and increased fire behavior.

Before describing plant communities and fuel models, a general description of fuels may be helpful. Fuels are made up of various components of the vegetation, both live and dead. The effect that fuels have on the ignition, spread, intensity, and duration of fire varies according to plant species, size, amount, compactness, condition (live or dead fuels), moisture content, mineral content, horizontal continuity, and vertical arrangement of those fuels. For instance, fuel load, size class distribution, and arrangement of fuels control ignition and whether a fuel will sustain a fire. Horizontal continuity influences whether a fire will spread or not and how steady that rate of spread may be. Fuel loading and vertical arrangement influence flame length and the ability of the fire to "torch out" in the overstory. With the proper horizontal continuity in the overstory (such as within dense pitch pine), the fire may develop into a crown fire.

Wildland fires are typically spread by fine fuels such as leaves, needles, and twigs on the surface and in tree canopies. These are known as one-hour time lag fuels (material < ¼ inch in diameter) that can quickly absorb moisture from the air or lose that moisture if humidity decreases. They are capable of drying out or losing two-thirds of their moisture content in about one hour. For example, on a sunny spring day, these fine fuels can rapidly dry and increase in flammability from early morning to mid day as humidity decreases. Ten-hour time lag fuels (twigs and small branches between 1/4 inch to 1 inch in diameter) are ready to burn within 10 hours of drying time. They also help spread wildland fires because they ignite and burn quickly. 100-hour time lag fuels (branches and slash between 1 to 3 inches in diameter) equilibrate over the course of many days and are slower to ignite. 1000-hour time lag fuels (> 3 inches in diameter) are basically trees and slash that need 1000 hours of dry time before they would combust. Long periods without rain can significantly affect the ability of 100-hour and 1000-hour fuels to burn. They may contribute to the intensity of a wildland fire creating local pockets or jackpots that may flare up and cause problems with mop-up but these larger fuels contribute little to the rate of spread.

Several plant communities within the Punkhorn are prone to burning; having formed on extremely acid and excessively drained soils. This dry and acidic environment slows the decay of organic matter and leads to thick accumulations of litter and duff. Many of the constituent plants of the communities, such as black huckleberry, scrub oak and pitch pine produce volatile substances in their leaves and stems; these live fuels contribute to the spread and intensity of fire. The dense black huckleberry or scrub oak understory tends to form a horizontally continuous layer of fine fuel through which fire spreads. The retention of dead branches on stems and the trapping of fallen twigs and branches within the shrubs provide well-aerated fuels. The dense shrub layer along with ladder fuels such as greenbrier and bittersweet, contribute to the vertical arrangement of fuels, thereby increasing the possibility of scorching of canopy foliage or crowning of fires within the canopy.

Pitch pine and other conifers tend to carry fire through the tree canopy more readily than oaks. From a distance, pine stands look fresh and green. Closer inspection generally reveals that the greenness is a shell enveloping a core of dry needles, twigs, and branches. The piney aroma we often enjoy while walking through a pine stand is actually a combination of highly flammable organic compounds produced in the green needles during photosynthesis. If black huckleberry, scrub oak and pitch pine fuel loadings are left unchecked and continue to accumulate, they can trigger far more severe, high intensity wildfires that threaten not only the ecosystem, but also private property in the surrounding areas.

PLANT COMMUNITIES AND CORRESPONDING FUEL MODELS

Brief descriptions of the plant communities of the Punkhorn Parklands follow. Nine plant communities are described. These descriptions are based on fieldwork completed during the winter and summer of 2005. These generalized groupings of plant communities were completed to evaluate current vegetative conditions, wildland fuel conditions, and wildfire risk. Brief fuel discussions and fire behavior predictions accompany the plant community descriptions. Table 1 provides an outline of plant communities or vegetation types, along with corresponding fuel models, topographic position, and approximate size. Figure 2 is a base map of the Punkhorn Parklands depicting vegetation from available orthophotography.

Fuels are discussed in terms of standardized fuel models developed by the U.S. Forest Service (Anderson 1982, Rothermal 1983, Scott and Burgan 2005) to help estimate fire behavior. Corresponding fuel models that "best fit" plant communities within the Punkhorn are discussed after each plant community description. Fuel models are important tools for land managers to assess wildfire risk and to determine prescribed fire parameters. Fuel models are used in mathematical modeling of fire behavior and fire danger rating. They are presented in fuel groups: grassland, shrubland, timber, and slash. The *BEHAVE Fire Modeling System* is a software application to predict wildland fire behavior for fire management purposes. The program is designed for use by fire managers who are familiar with fuels, weather, topography, and wildfire situations. For more information, the *BEHAVE PLUS* fire behavior prediction system may be downloaded from the Internet (www.fire.org/tools). Table 2 provides general characteristics of fire behavior for vegetation and corresponding fuel models within the Punkhorn. More specific fuel discussions and fire behavior predictions will be provided in forthcoming prescribed fire plans for management units.

Mixed Oak – Pitch Pine Forest

This is the prevalent forest type, occupying over 60% of the area. It may be found on hills, slopes, and level terrain of upland areas. Scarlet oak, white oak, black oak and pitch pine dominate the canopy, forming 60-80% cover. Trees may reach 30-45 feet tall. The subcanopy is

composed of scarlet oak, pitch pine, black oak and white oak, forming 5-20% cover of trees and roughly 18-30 feet tall. Scarlet oak, highbush blueberry, and white oak are common in the tall shrub layer. Sassafras and white pine occur as scattered individuals within the tall shrub layer. Black huckleberry and lowbush blueberry form a continuous low shrub layer, forming 80-100% cover of shrubs and 2-4 feet high. Common greenbrier, winterberry, wild sarsaparilla, bracken fern, and pink lady's-slipper occur to a lesser extent. Greenbrier can be locally abundant for reasons that are not entirely clear. The greenbrier stems are mostly short, occurring among and above the huckleberry bushes. In areas were fire has occurred, a more open canopy woodland structure is a result, with a profusion of regenerating scarlet, white oak, and post oak sprouts. A small stand of post oak, an uncommon tree, is found north of Boot Swamp. The litter layer within the mixed oak – pitch pine forest is generally 2 inches thick, overtopping partly decomposed duff, which is another 2-3 inches thick.

In general, the mixed oak – pitch pine forest should be regarded as fire prone due to droughty soils, thick litter, and the prevalence of a continuous ericaceous shrub understory. Fires are likely to be surface fires carried through the shrub understory burning with moderate intensity. Fast moving fires may occur in the spring with multiple tree torching in pine dominated areas. During periods of low humidity and high winds, rates of spread and flame lengths increase dramatically. Under dry conditions, severe burns may occur if fires enter the duff that accumulates under oak litter. As greenbrier and pine increase in the understory, so does the potential for ladder fuels carrying fire into the forest canopy. The mixed oak – pitch pine forest is represented by Fuel Model 6 of Anderson's (1982) standard models for estimating fire behavior.

Mixed Oak Forest

This forest is found as small pockets on hilly terrain around Calf Field Pond. White oak and black oak dominate the canopy, forming 60% cover. American beech and pitch pine occur in the canopy to a lesser extent. Trees may reach 35-45 feet tall. Bayberry, highbush blueberry, and witherod are common in the tall shrub layer. Sassafras, white oak, and white pine occur as scattered individuals throughout the tall shrub layer. Lowbush blueberry, bracken fern, and sarsaparilla form a fairly continuous low shrub and herb layer. Black huckleberry is scattered in the low shrub layer. Small stands of American beech are found along north facing mesic side slopes in the vicinity of Quarry Road and calf Field Road. Litter is patchy under American beech stands, and increases under mixed oak and pitch pine, ranging from 1 to 2 inches.

Standard Fuel Model 9 represents large portions of the mixed oak forest. Lowbush blueberry, the dominant ground cover, is less volatile than black huckleberry and surface fires tend to move more slowly through these low shrub fuels. However, areas supporting higher concentrations of black huckleberry, bayberry, and pitch pine are better represented by Fuel Model 6. During periods of low humidity and high winds, rates of spread and flame length may increase within these areas. The tall shrub fuels may act as ladder fuels causing multiple tree torching and short crown runs within the pitch pine. Throughout much of this area, basal area of pitch pine was estimated at 30 square feet/acre.

Pitch Pine Forest

The Pitch Pine Forest occurs within the southern portion of the property. This is a pine-dominated forest rather than a true "pine barrens". Pitch pine is the dominant tree in the forest canopy, forming 40-60% cover. Trees may reach 20 to 45 feet tall. Pitch pine is the dominant species in the subcanopy but trees of scarlet oak, white oak, and black oak may be admixed with pine, forming 40% - 60% cover and reaching 18 - 30 feet tall. Scrub oak, black oak, and scarlet oak are common in the tall shrub layer, forming 20-40% cover. Black huckleberry and lowbush blueberry form a continuous low shrub layer, forming 80-100% cover, 1-3 feet tall. Winterberry,

bracken fern, and pink lady's-slipper occur as scattered individuals within the herb layer. The leaf litter is 3 inches thick, overtopping partly decomposed duff, 2-3 inches thick.

The pine forest is fire-prone due to the prevalence of black huckleberry and scrub oak in the shrub understory. This vegetation has the potential to burn with moderate to very high intensities. Under dry conditions and high winds, flame lengths and rates of spread increase dramatically. As scrub oak increases in the understory, so does the potential for ladder fuels to carry fire into the forest canopy, causing multiple tree torching and crown fire runs within the pitch pine forest. Basal area for pitch pine was estimated at 80 -90 square feet/acre throughout much of this area. The pitch pine forest is represented by Standard Fuel Models 4 and 6.

Immature Pitch Pine Stands

Fairly monotypic dense stands of pitch pine occur within the vicinity of the Deerfield Subdivision. It appears that topsoil was scraped away within portions of the area over the past 15 – 20 years. The pitch pine canopy is closed, forming 75-85% cover, 20 – 30 feet tall. Trees average 3 to 8 inch diameter at breast height. Understory vegetation is variable consisting of common greenbrier, bayberry, highbush blueberry, black huckleberry, red cedar, and crinkled hair grass. Pine is admixed with larger black oak and scarlet oak with sapling sassafras. Red maple and sweet pepperbush may be found within the understory on more mesic soils approaching wetlands.

Within dense interior portions of stands, understory vegetation is scarce with thick accumulations of pine needle duff. Basal area for pitch pine is high, estimated at 220 – 270 square feet/acre. Within the shaded areas, slow moving surface fires may carry through the compact needle litter and hairgrass and are best represented by Standard Fuel Model 8. However, portions of these stands contain abundant black huckleberry and common greenbrier. Fire may burn through the surface and shrub strata with moderate to high intensities. Shrubs and vines may act as ladder fuels carrying fire into the pitch pine canopy, causing multiple tree torching and crown fire runs within the dense pitch pine. Other portions of the young pitch pine stand are best represented by Standard Fuel Model 7. During weather conditions involving high temperatures, high winds, and low humidities, fire hazard increases greatly within this fuel type.

Right-of-Way Shrubland

Periodic mowing of the transmission line right-of-way has maintained early successional shrubland conditions. The tall shrub layer is fairly open and dominated by short black oak, scarlet oak, white oak and pitch pine, forming 40 % cover. Black huckleberry, Pennsylvania sedge, common greenbrier, lowbush blueberry, hairy bush clover, little bluestem, and yellow wild indigo are characteristic within the low shrub and herb layer, forming 80 – 100% cover. The litter layer is approximately 1 inch thick and comprised of tree leaves and graminoid thatch. The vegetation should be regarded as fire prone. Fine fuels from the grasses and sedges are present. The powerline right-of way is represented by Standard Fuel Models 1 and 4. Fire intensity may be low to high depending on when vegetation was last cut for powerline maintenance. Powerline maintenance is supervised by NSTAR Power and expected to occur every five years.

Shrub Swamps

Shrub dominated wetlands occur along the Punkhorn River, in small kettlehole depressions, and along pond margins, which are seasonally flooded. Highbush blueberry, winterberry, swamp azalea, and leatherleaf may form a continuous shrub layer with sweet pepperbush and sheep laurel occurring to a lesser extent. Young red maple, tupelo, and pitch pine trees are scattered throughout the wetlands. Low herbaceous vegetation is sparse. Virginia chain fern, marsh fern, wool-grass, reed canary grass, and large bog cranberry often occur over sphagnum moss. Many of

the shrub swamps were stripped of vegetation in the late 1800's and farmed for commercial cranberries up until the mid 1900's.

A common variant observed during fieldwork is the water willow and sweet pepperbush shrub swamp, often associated with areas of standing water. Leatherleaf may occur to a lesser extent within the shrub layer. The herb layer is sparse and may include reed canary grass, sphagnum moss, other mosses, and marsh St. John's-wort over muck.

The shrub swamp is represented by Standard Fuel Model 5. The leaf litter is generally compact above sphagnum or muck and fire tends to move very slowly on the surface. During high water periods, which may last for several months of the year, fire will not carry through these wetlands and they may serve as firebreaks. However, under extreme weather conditions involving drought, high winds, high temperatures, and low humidities surface fires may move into the shrub layer and flare up in heavy fuel concentrations. In addition, severe and difficult to extinguish ground fires may occur in peat deposits during drought periods.

Common Reed Stands

Small stands of common reed and broad-leaved cattail are scattered throughout the Punkhorn wetlands. Stands of common reed may build up thatch and are potential fire hazards depending on their location. Dead and cured standing stems of common reed may form almost impenetrable thickets of highly flammable materials. Common reed stands are best represented by Standard Fuel Model 3. Fires may be intense and fast moving when accompanied by high winds, high temperatures, and low humidities.

Tupelo – Red Maple – White Oak Forest and Swamp

This forest occurs on moist toe slopes, within wet depressions, and along the margins of ponds. Tupelo and red maple may reach 40 – 60 feet tall. Pitch pine occurs scattered throughout the forest canopy. Sweet pepperbush, highbush blueberry, swamp azalea, black huckleberry, inkberry, and common greenbrier form a discontinuous shrub layer. Typical herbs scattered throughout the understory include wild sarsaparilla, chain fern, and cinnamon fern. Small open water areas within may support dense stands of winterberry.

The litter layer is compact and generally less than 1 inch thick. Fires move slowly through the surface fuels during most of the year. The tupelo - red maple- white oak forest and swamp are best represented by Fuel Model 8. During very dry and windy conditions fire potential increases, especially in pockets with greenbrier and inkberry. Greenbrier may act as a ladder fuel carrying fire into the pitch pine canopy.

Coastal Plain Pondshore

A herbaceous community of exposed pondshores influenced by changing water levels. The emergent exposed pondshore supports Canada reed grass, flat-topped goldenrod, pondshore rush, golden pert, beaksedges, lance-leaf violet, and dwarf St. John's-wort. Bayonnet rush, spike rushes, and pipewort are found in the semi-permanently flooded zone. Deeper water areas support yellow water lily, white water lily, and spike-rush. Numerous rare and uncommon species are found within the coastal plain pondshore communities of the Punkhorn including Plymouth gentian, pondshore knotweed, redroot, thread-leaved sundew, hyssop-hedge nettle, and the spatterdock darner. Litter is sparse with large areas of exposed sand, cobble, or muck substrates. Fire does not carry through this community and it serves as a firebreak.

Table 1. Generalized Vegetation Types and Corresponding Fuel Models of Punkhorn Parklands

Vegetation Type	Topographic Position	Fuel Model	% Area approximate
Mixed Oak – Pitch Pine Forest	Level terrain, rolling hills, and side slopes	6	60%
Mixed Oak Forest	Rolling hills	9	5%
Pitch Pine Forest	Level terrain	4, 6	10%
Immature Pitch Pine Stand	Level terrain	7, 8	2%
Right-of-Way Shrubland	Hills and level terrain	1, 4	< 1%
Shrub Swamp	Wetland depressions, pond margins	5	15%
Common Reed Stand	Depressions	3	<1%
Tupelo–Red Maple–White Oak Forest and Swamp	Toe slopes, wetland depressions, and pond margins	8	<5%
Coastal Plain Pondshore	Pond Margins	Will not carry fire	<2 %

Table 2. Summary of Fire Behavior Characteristics for Fuels at Punkhorn Parklands

Fuel Model – Fuel Type	Fire Behavior Characteristics	% Area
Fuel Model 1 - grassland w/ low forbs	Fine herbaceous fuels that are cured or nearly cured carry fire. Moderate flame lengths: less than 4 ft High rates of spread: 78 ft/min Very small patchy areas along powerline right-of-way.	< 1
Fuel Model 3 - common reed stands	Dead standing stems up to 4 –6 feet tall carry fire w/ moderate winds. High flame lengths: 12 ft (+) Moderate to high rates of spread: 100 ft/min Small stands within wetland depressions.	< 1
Fuel Model 4 - Scrub oak openings within pitch pine forest - r-o-w shrubland (3+ yrs post mowing)	Fire carried by abundant surface fuels, such as oak leaves, pine needles, and cured herbaceous material. Fire will spread into shrub layer except under low wind and high moisture levels. Shrub layer contains volatile material. Fires of high intensity and moderate rate of spread. High flame length: 6-20 ft Rates of spread: 6-30 ft/min	< 2 < 1
Fuel Model 5 - Shrub swamps	Fire carried mainly on surface by the litter cast from shrubs. Foliage contains little volatile material. Stands may reach 6 feet high but have poor burning properties because of live (nonvolatile) vegetation and shading. High winds and extreme drought needed to carry fire into shrub mid-story. Low flame lengths and low rates of spread. May act as firebreaks during seasonally wet periods.	15
Fuel Model 6 - Mixed oak – pitch pine forest - Pitch pine forest	Fire carried mainly through the continuous and volatile shrubs, such as huckleberry and scrub oak. Pines are susceptible to torching and crowning, especially in areas w/ significant ladder fuels. Crowning could lead to fire of catastrophic scale and intensity. Fire behavior moderate to intense. High flame lengths: 6 ft (+) Moderate rates of spread: 10-30 ft/min.	60 8
Fuel Model 7 - Immature pitch pine stands with continuous understory	Fire behavior intense if significant shrub layer and ladder fuels present. High potential for crowning in dense pitch pine. Crowning could lead to fires of catastrophic scale and intensity. High flame lengths: 5-8 ft (+); Rates of spread: 10-20 ft/min	<2
Fuel Model 8 - Tupelo-red maple-white oak forest and swamp - Immature pitch pine stands w/ little understory	Fire carried by surface fuels, which are often shaded, compacted, and shallow. Low intensity fire behavior under all but the most extreme conditions. Low flame lengths: < 1 ft; low rates of spread: 1- 2 ft/min.	5 <1
Fuel Model 9 - Mixed oak forest	Fire carried primarily by fine surface fuels comprised mostly of hardwood litter and lowbush blueberry. Concentrations of tall shrubs and ladder fuels may cause torching. Low to moderate intensity fire behavior. Average flame length: 2.5 ft, rate of spread: 7.5 ft/min	5

SURROUNDING LANDSCAPE AND INHOLDINGS

The wildland/urban interface is defined as the area where combustible homes and other facilities meet combustible vegetation. This interface includes a wide variety of situations, ranging from individual houses and isolated structures to subdivisions and rural communities surrounded by wildlands. While Upper Mill Pond and Walkers Pond provide natural firebreaks along the western boundary and Seymour Pond provides a firebreak along a portion of the eastern boundary of the parklands, extensive residential development has occurred along the north, northeast, and southern boundaries of the Punkhorn Parklands. More than 50 homes are located in close proximity to the conservation area or as inholdings within parklands, Figure 2. Boundary lines delineating private and public land are not easily located. In many cases, mixed oak and pitch pine forest with a continuous understory of huckleberry and other ericaceous shrubs border private and town-owned land, separated only by narrow open spaces around homes. Very few homes have adequate buffers of non-burnable material around them.

Residential inholdings are generally two-story buildings with garages and/or barns. Roofing is generally asphalt tiles, and white cedar siding appears to be the most common exterior wall surface. Decks are found on approximately half of the inholdings. Fencing is usually limited to occasional split rail style fences. Overhangs vary, but are generally less than 6 inches. Within the Archies Cartway inholdings, there is an abundance of agricultural use and associated barns and outbuildings. Zoning in this part of town requires a 40-foot setback from the road and a 25-foot setback from lot side and back property lines, allowing homes to be as close as 50 feet apart. Sometimes, houses in close proximity to each other screen with evergreens along the boundary line, posing an additional fire risk to these homes. Although none observed, there may be some exterior heating oil tanks associated with inholdings.

Landscaping within residential areas is mixed deciduous and coniferous. Common ground covers are short grass, mixed vegetation, and softwood mulch. Most structures do not have 30 feet of defensible space on all sides. There are heavy ladder fuels often within 30 feet of dwellings. Natural forest vegetation is often within close proximity to dwellings. Pitch pine and other flammable vegetation may be within 30 feet of many structures. Firewood and fuel storage is commonly found within 20 feet of structures.

Residential areas within the Deerfield Subdivision are very vulnerable to wildland fire, given the prevailing wind direction and the subdivision's position as a residential peninsula surrounded by fire prone vegetation. Numerous homes in this area would be at risk from a wildfire event and vulnerable to ignition from firebrands, radiation, or convection from a wildfire. Residential inholdings within the parklands are also at great risk. Particularly, inholdings in the vicinity of Westgate Road and Black Duck Cartway, which are located northeast of flammable pitch pine forest. Areas supporting agricultural use, primarily equestrian, such as within the Archies Cartway inholdings, may be less vulnerable due to the paddocks and fields that serve as firebreaks. A new housing subdivision is being developed along the southeast boundary of the Punkhorn Parklands and the Harwich town line in proximity to fire-prone vegetation.

There is a major electric utility line and right-of-way located on a small portion of the northern property boundary, northwest of Calf Field Pond. NSTAR Power Company manages the right-of way vegetation. There are aerial utility lines along Cranview Road, portions of Westgate Road, Eagle Point Road, Archies Cartway, Eastgate Road, and throughout the Deerfield Subdivision.

The Brewster Water Department maintains care and custody of approximately 30 acres of upland and wetland around the Greensand Water Treatment Facility and well site, located adjacent to the main parking area off of Westgate Road. The treatment facility has paved access around all sides

of the building and a grassy buffer area beyond the pavement. The concrete structure is generally clear of woody vegetation a distance of 30 feet on all sides. Beyond this zone, mixed oak and pitch pine forest contains shrubby understory and ladder fuels. There is a concentration of dense and highly flammable immature pitch pines to the north and east of the facility. A small isolated wetland filled with invasive plants is located south of the treatment facility and opposite the intersection with Eagle Point Cartway and Westgate Road. This disturbed wetland is characterized by common reed grass, Japanese knotweed, Asiatic bittersweet, cypress spurge, and white poplar. The invasive non-native plants such as common reed grass, Japanese knotweed, and Asiatic bittersweet create a fire hazard. Thinning of pine and control of ladder fuels and invasive species would provide increased protection for town improvements in this area. The Brewster Water Department also maintains care and management of approximately 150 acres of open space land surrounding well sites and future well sites southeast of the junction with Black Duck Road and Westgate Road. A new road was recently cut into the mixed oak – pitch pine forest south of Boot Swamp to facilitate installation of a test well and exploration for future water resources.

The Town-owned Mattot House is located on a peninsula of upland surrounded by the Punkhorn River wetland system. While the wetlands may provide some level of protection, the un-pruned mix of deciduous and evergreen landscaping growing very close to and overhanging the building pose a threat to the structure.

Commercial activities within the area are limited to cranberry production along the southern boundaries adjacent to Elbow Pond and Hinckleys Pond. There is one active bog within an inholding along Westgate Road.

In addition to the direct threat of wildfire, smoke associated with a wildland fire could impact sensitive resources in the surrounding area. Hundreds of homes are located to the north and east within 0.5 mile of the property. Besides health impacts, smoke can impair visibility. At high relative humidities, small concentrations of smoke can create fog. Also, at high humidities and fuel moisture levels, vegetation burns poorly, creating more smoke than when the same vegetation would burn in low humidities and low fuel moisture levels. Major roads within a mile radius of the Punkhorn Parklands and potentially impacted by a large wildfire event include Satucket Road, Slough Road, Route 6A, Route 124, and Route 6, the Mid-Cape Highway.

The smoke generated from uncontrolled wildland fires can threaten public safety and diminish air quality. Prescribed fire can mitigate smoke management concerns by assuring that atmospheric conditions on the day of a burn provide good lift and dispersal of smoke and that burns are scheduled when winds will transport smoke away from sensitive areas. Smoke will also be controlled by ensuring that fine fuels are sufficiently dry to burn well and that moisture in larger woody material and duff is high (Low KBDI). Reducing fuel loads by mechanical removal will also produce less smoke.

HISTORIC, SCENIC, AND RECREATION RESOURCES

The Punkhorn Parklands have a long and rich land use history. The Saquatucket Tribe hunted and fished within the area for thousands of years. Current roads and trails within the parklands were probably native foot trails linking the ponds and Harwich's Herring River to the south shore. Early colonial land uses most likely ranged from woodlot management to sheep grazing. Forested areas show evidence of past fire. Many wetlands show signs of former cranberry production. Large soil pits are evident within the Calf Field Pond area, where glacial erratics were removed for jetty construction in Cape Cod Bay.

A beautiful network of trails forms a patchwork across the Punkhorn Parklands linking interesting wetlands, forested areas, ponds, and other natural features. The trails throughout the Punkhorn Parklands are part of the Cape Cod Pathways, a network of walking paths linking open space throughout Cape Cod. The trail system throughout the Punkhorn appears to be well maintained and frequently used by local residents and visitors. The trails allow visitors to enjoy and learn about the natural world around them. The area serves many passive recreation functions and protects significant natural resources, as well as the scenic and natural character of forest and wetlands within Brewster. The Punkhorn Parklands hold tremendous potential for the interpretation of the natural and cultural landscapes of Cape Cod.

Locational road signs are in place at major road and trail intersections. These signs help visitors identify their location within the property and may also serve as important location guides for rescue and firefighting personnel working in the area. The trailhead signs will require periodic vegetation management to protect structures from wildfire.

Frequently observed recreational uses occurring on the property including hiking, canoeing, horseback riding, walking and nature study. Mountain biking is not permitted but is not currently enforced. Dirt bikes, three and four wheeled all terrain vehicles, and snowmobiles are not allowed on trails and within forested areas. Camping and campfires are also not allowed. As with most publicly owned open space areas, there was evidence of campfire pits, forts, spent fireworks, and unauthorized trails throughout the Punkhorn Parklands.

NATURAL RESOURCES & SPECIES OF CONCERN RESPONSE TO FIRE

The mixed oak and pitch pine forests of the Punkhorn Parklands are adapted to survive low to moderate intensity fire. Black and white oak trees are capable of surviving low intensity fire due to thick bark. When oaks are top-killed by moderate intensity fire, trees may sprout readily from stumps (Abrams 2005, Abrams 1992, Lorimer 1993, and Rawinski 2000). Severe and high intensity fire, generally associated with wildfire, may consume the duff, injure root systems, and kill trees. Severe wildfires may also scorch acorns in the duff layer, preventing their germination. Periodic low to moderate intensity prescribed fire is likely to open up the understory temporarily, allowing enhanced growth of black oak and white oak sprouts and increasing the importance of oak within these mixed oak and pine forests. Throughout much of the northeast, there is a concern that oak is not regenerating and that lack of periodic low intensity fire is a contributing factor.

Pitch pine with its thick corky bark and many dormant buds is also adapted to survive fire. Even after foliage and leaves are killed, epicormic shoots may be released along the bole and provide new foliage. Older trees tend to survive moderate to high intensity fires. Fires during the growing season are more likely to kill pines, especially if feeder roots are damaged. Pines are more susceptible to turpentine beetle attack following fire. Severe wildfires are likely to promote germination of pitch pine because the duff layer is consumed and mineral soil exposed. Therefore, severe fires tend to increase the importance of pitch pine in the community and the likelihood of serious crown fire in future unplanned ignitions (Patterson and Ruffner 2002).

High severity and intensity fires may cause actual tree mortality and local extirpation of populations. Although many oaks exhibit the ability to be top-killed and sprout vigorously after fire, fires that are too intense or severe will kill trees completely. Arson fires during drought years may create high severity and intensity fires. Fuel loadings within the forest – residential ecotone are exceptionally high due to extensive build-up of shrubs and thick vines such as Asiatic bittersweet and common greenbrier, which create volatile, laddered fuels and unusually intense fire behavior. Careful prescribed fire planning and execution, selective thinning of pitch pine, and control methods for shrub and ladder fuels will help mitigate this threat.

The Natural Heritage and Endangered Species Program of the Massachusetts Division of Fisheries and Wildlife report the following rare species occurrences from the Punkhorn Parklands:

Common Name	Scientific Name	State Status
Vascular Plants		
Adder's Tongue Fern	*Ophioglossum pusillum*	Threatened
Resupinate Bladderwort	*Utricularia resupinata*	Threatened
Bushy Rockrose	*Helianthemum dumosum*	Special Concern
Common's Panic Grass	*Dicanthelium commonsianum* v. *addisoni*	Special Concern
Plymouth Gentian	*Sabatia kennedyana*	Special Concern
Puritan Knotweed	*Polygonum puritanorum*	Special Concern
Redroot	*Lacnanthes caroliana*	Special Concern
Hyssop Hedge Nettle	*Stachys hyssopifolia*	Watch List
Post Oak	*Quercus stellata*	Watch List
Invertebrates		
Barrens Bluet	*Enallagma recurvatum*	Threatened
Scarlet Bluet	*Enallagma pictum*	Threatened
Water Willow Borer Moth	*Papaipema sulphurata*	Threatened
Spatterdock Darner	*Aeschna mutata*	Special Concern
Vertebrates		
Northern Parula	*Parula americana*	Threatened
Bridle Shiner	*Notropis bifrenatus*	Special Concern
Eastern Box Turtle	*Terrapene carolina carolina*	Special Concern

Rare plants such as resupinate bladderwort, Plymouth gentian, puritan knotweed, redroot, and hyssop hedge nettle are restricted to coastal plain pondshore habitats around Upper Mill Pond, Walkers Pond, and Seymour Pond. These pondshore habitats are less prone to burning and rare plants are unlikely to be impacted by wildfire events or prescribed fire activities.

Adder's Tongue Fern, a threatened plant, is found in seepy wooded openings in the vicinity of Walker's Pond and Upper Mill Pond. Botanists, such as Robert McMaster who have visited the area over a period of time, recommend carefully clearing shrubs and pitch pine from areas with Adder's Tongue Fern, so that rare plants are not eventually shaded out. Severe wildfire events during drought periods would likely damage rare plants and substrates supporting them. Rare plants and habitat are unlikely to be damaged by low intensity wildland fire or prescribed fire during periods of high soil moisture.

Common's Panic Grass, a species of special concern, is found in small sandy woodland openings throughout the Punkhorn Parklands. This rare plant and other uncommon plants reported from the Punkhorn in the mid 1980's such as butterfly-weed, wild lupine, and velvety bush-clover, require semi-open sandy soils (LeBlond 1987). These four plants are likely to respond favorably to prescribed fire when applied during the appropriate time of year and rotation.

Small stands of Post Oak were reported from forested areas north of Boot Swamp. This uncommon oak species prospers in woodland openings and fire adapted ecosystems. Low and moderate intensity fire will help maintain seedbeds for oak regeneration and increase available light to seedling and sapling post oaks.

The Northern Parula, a small woodland warbler listed as threatened, is found within swampy areas, as well as wooded bog and pond margins of the Punkhorn. It often nests in trees with hanging old-man's beard lichen. These wetland habitats are less prone to burning. Severe wildfire events during periods of extreme drought could damage habitat for Northern Parula.

Invertebrates, such as the Barren's Bluet Damselfly and the Scarlet Bluet are found along the sandy and mucky shallow shores of the Punkhorn's ponds, especially in areas supporting emergent vegetation such as rushes and sedges. These pondshore habitats are less prone to burning and rare damselflies and darners are unlikely to be impacted by wildfire events or prescribed fire activities in upland areas. The Water Willow Borer Moth is restricted to wetlands that support water willow and these wetlands are unlikely to carry fire.

The Eastern Box Turtle, a species of special concern reported in the vicinity of Seymour Pond and Upper Mill Pond, is likely to occur throughout upland and wetland habitats of the Punkhorn. Box Turtles are common in fire adapted ecosystems. Populations are most vulnerable to severe wildfire events during the growing season. Populations are likely to respond favorably to low intensity prescribed fire when applied during appropriate times of year ensuring adequate soil moisture and on a rotation schedule that ensures adequate portions of the habitat remain undisturbed and available for box turtles.

Management activities proposed within designated habitat for the above listed rare species require review by the Brewster Conservation Commission and the Natural Heritage and Endangered Species Program of the Massachusetts Division of Fisheries and Wildlife. In certain cases, seasonal restrictions in the use of low impact equipment and prescribed fire may be required.

Common wildlife species reported within the Punkhorn Parklands include red fox, gray fox, eastern coyote, white-tailed deer, gray squirrel, red squirrel, striped skunk, eastern chipmunk, raccoon, opossum, and muskrat. More extensive lists of wildlife occurring in the area of the Punkhorn Parklands are provided in the Open Space and Recreation Management Plan for the Punkhorn Parklands (DiGregorio 1988).

Blair Nikula conducted breeding bird surveys within the Punkhorn Parklands for several consecutive years in the mid 1990's. Birds commonly observed during the surveys included Mourning Dove, Eastern Wood-Pewee, Blue Jay, American Crow, Black-capped Chickadee, Tufted Titmouse, Hermit Thrush, American Robin, Gray Catbird, Pine Warbler, Ovenbird, Common Yellowthroat, Rufous-sided Towhee, and American Goldfinch. Over forty-seven species were recorded during the surveys. Interesting uncommon breeders included Whip-poor-will, Nashville Warbler, and Scarlet Tanager (Nikula 1997). Rafting waterfowl often observed on the ponds include Bufflehead, Ring-necked Duck, Common Merganser, Greater and Lesser Scaup, and Common Golden-eye (DeGregorio 1988).

The presence of open water, shrub wetlands, forested swamps, and mixed oak and pitch pine forests provides habitat for a variety of reptile and amphibian species. In addition to Box Turtles, the common Eastern Painted Turtle and Common Snapping Turtle are found in pond and wetland areas. Common snakes reported include the Northern Water Snake, Northern Black Racer, northern Ribbon Snake, Eastern Hognose Snake, and Northern Ring-neck Snake. Spring Peepers, Wood Frogs and Gray Tree Frogs are heard singing in the spring and summer. Red-backed Salamanders are common (DeGregorio 1988).

The detrimental effects on wildlife from large, fast-moving wildfire or severe wildfire, which burns into the litter and duff, are greater than the minimized effects of a carefully planned and

executed low-intensity prescribed burn carried out on a small portion of the property at the appropriate time of the year.

Lacking detailed baseline information on wildlife within the area, one can only speculate as to possible changes in wildlife use resultant from prescribed fire or mechanical treatments to reduce fuel loads within designated areas of Punkhorn Parklands. Plant species composition will likely remain the same or increase slightly within these zones. Structural changes within the plant community are expected. Such changes will reflect changes in soft mast and hard mast production and mid-story cover for wildlife. Selective thinning of pine will increase canopy gaps providing increased light to oak trees. This will allow for more vigorous growth of oaks, resulting in increased hard mast (acorn production). Reduction in height and cover of invasive vines and understory shrubs such as black huckleberry will provide increased light for forest herbs and low growing shrubs. The first year following prescribed fire or mowing within the understory shrub layer, soft mast (berries) production will decrease. By the third year, soft mast production will increase.

Most healthy, mature birds and mammals can escape the active flame front in a prescribed burn. Prescribed burn rates of spread do not generally exceed 15-20 feet per minute and flame lengths are low. Most animals are able to flee from the fire or find safety in a burrow. Very young gray fox and other small mammals that have shallow dens may be more susceptible to fire during the reproductive season. Amphibians and reptiles are also more vulnerable depending on the time of year.

Vertebrates and invertebrates that cannot escape the direct path of fires or mowing equipment may be injured or in some instances killed. This includes relatively immobile organisms such as eggs or fledglings and slow-moving organisms such as the Box Turtle. Timing prescribed burning or mechanical operations for late growing season and dormant season and using lightweight equipment, which minimizes soil compaction, will greatly reduce direct impacts to wildlife from treatments. Also, prioritizing treatment zones and establishing a rotation of treatment blocks will accommodate many wildlife species. Setting a goal that no more than 5% of the property (depending on conservation targets, as well as logistical and financial constraints) is under mechanical or prescribed fire treatment within a given year is necessary to balance competing resource objectives.

LOCAL PREPAREDNESS AND FIREFIGHTING CAPABILITIES

The Punkhorn Parklands fall within the jurisdiction of the Brewster Fire Rescue Department. The headquarters fire station is currently staffed and serves the entire Town of Brewster. Headquarters is located less than 2.5 miles northeast of the Punkhorn Parklands near the intersection of Routes 137 and 6A. A second station operates seasonally and is located in East Brewster and shared with the Massachusetts Department of Conservation and Recreation's Nickerson State Park. The Brewster Fire Rescue Department has a rapid response time and a variety of resources available for fire suppression. An apparatus roster for the Town of Brewster may be obtained on line at www.town.brewster.ma.us/brewfire or www.capecodfd.com.

The Brewster Fire Department utilizes the Barnstable County Control Mutual Aid System for Cape Cod, which provides assistance from other area fire departments on Cape Cod in suppressing large forest fires and structural fires. The Mutual Aid Center is located in the Barnstable Sheriff's Department Communication Center in Barnstable Village.

The Massachusetts Department of Conservation and Recreation's (DCR) District 1 Fire Tower in Brewster is located in Nickerson State Park in East Brewster. This tower is only occasionally

manned. Other nearby DCR Fire Towers are located in Dennis and Wellfleet. The Dennis Tower is the most frequently manned tower. According to Brewster Fire Chief Roy Jones, the Wellfleet Tower is infrequently manned but provides the best cross view over the Punkhorn. Brewster and Dennis do not have adequate cross views of the Punkhorn. Fire towers can be instrumental in quickly spotting, locating, and reporting wildfires within their jurisdiction to respective fire departments. Other detection methods include resident inholding phone calls, adjacent neighbor phone calls and cell phone reports from park users.

During periods of high fire danger, DCR's District 1 conducts ground patrols, contracts fixed aircraft for fire detection, and works closely with the Town of Brewster, County, and Federal agencies such as Otis ANGB for additional aerial patrols for fire detection. The Keetch Byram Drought Index relates current and recent weather conditions to potential or expected fire behavior. As stated earlier, the National Park Service tracks the KBDI at Cape Cod National Seashore in Wellfleet. In addition, the DCR Bureau of Forest Fire works closely with local weather stations and the National Weather Service to determine daily fire danger classifications for posting at State forest and park areas. Fire danger ratings indicate the potential for fire over large areas taking into account weather, fuel types, and live and dead fuel moistures. Fire danger classification is determined by the National Fire Danger Rating System (NFDRS). It is a measurement of a determined rate of fire spread from one to five, with a class 1day being very low and a class 5 day being extremely high. More information on NFDRS may be found at www.fs.fed.us/land/wfas. The NFDRS is often used with the Keetch Byram Drought Index to predict fire danger.

The closest hydrants to the Punkhorn are found within the Deerfield Subdivision and the Greensand Water Treatment Facility, Figure 4. Paul Hicks, Brewster Water Superintendent, is of the opinion sufficient flows are present within these two areas. These water lines are currently looped from Run Hill Road out to Route 124 and should have good flow capabilities. Nearby hydrants are shown on Figure 4, the road classification map for the Punkhorn Parklands. The new housing subdivision proposed in Harwich along the southern border of the Punkhorn and the Harwich municipal water supply land will include hydrants and town water.

A new water main is scheduled to be installed on Slough Road in the near future. This would provide a remote water source to the western portion of the Punkhorn. Although access to water sources from Slough Road to the Punkhorn are restricted to small apparatuses. A short and narrow corner near the intersection of Cranview Road and Black Duck Cartway currently limits access for firefighting apparatuses along this western side.

Superintendent Hicks reported that an 8-inch test well was recently installed in the area south of Boot Swamp within a portion of the 150-acre parcel under the care, custody, and control of the Brewster Water Department. If sufficient resources exist, a new well may be developed in this area. Over the longer term, Superintendent Hicks suggested a water line could be installed in from Slough Road, via Cranview Road to Black Duck Cartway and tie into this well site.

Upper Mill Pond is the only open water body with a landing within the Punkhorn and it is located in proximity to the water treatment facility hydrant. The south end of Upper Mill Pond (accessed at the end of Eagle Point Cartway), Seymour Pond and Walkers Pond have remote access where vehicles may come within several hundred feet of the ponds and pump water out of the ponds. Elbow Pond is accessible to the edge via cranberry bog dikes and sand roads, but these may be risky to traverse and difficult to access with heavy firefighting apparatuses.

A major staging area for firefighters and equipment would likely be adjacent to the main gravel parking area at the north entrance to the parklands. The parking lot itself has a narrow entrance and utility poles border its bounds. Another major staging area to the south would be the edge of pavement just over the Harwich town line on Westgate Road. It should be noted that high fuel loads in this portion of the Punkhorn warrant a staging area here but also pose some level of risk to firefighters and equipment.

ACCESS AND INTERIOR DIRT ROADS

Numerous dirt roads and paths provide access to the Punkhorn Parklands. The general public may access all open roads, Figures 3 and 4. Roads are identified with signs at major intersections. The major north to south road bisecting the property is Westgate Road. Major access from the south is gained via Westgate Road south along the Harwich and Brewster town line. From the west, access is gained from Black Duck Cartway off Cranview Road and Slough Road in West Brewster. From the north, access is gained from Westgate Road and Run Hill Road off Stony Brook Road. Sequattom /Seymour Road provides access along the southeast border of the parklands from Route 124. The Sequattom/Seymour Road access is likely the shortest route for the Brewster Fire Rescue Department but road conditions do not meet minimum access standards. The Brewster Fire Rescue Department would likely access the Punkhorn via Run Hill Road, as that road would provide the most rapid response time.

There was formerly additional access off of Great Fields Road via Massasoit Trail, however private residents have erected a locked gate on their property in the middle of Massasoit Trail. Portions of East Gate Road, Punkhorn Road, and Squantum Path are in poor condition. The Brewster Department of Public Works actively maintains the following roads within the Punkhorn: Westgate Road, Punkhorn Road, Black Duck Cartway, Massasoit Trail, and the northern sector of East Gate Road. Figure 4 features a generalized classification for roads within the Punkhorn Parklands. It should be noted that the interior dirt roads serve as important firebreaks and access for fire control. Most of these roads are between 8 to 14 feet wide and are unlikely to hold an intense wildfire event given the surrounding vegetation. Wide zones of reduced fuel loadings along road buffers and at road intersections are essential for firefighter and public safety. These widened zones of reduced fuels are often called shaded fuel breaks. and strategies to maintain them are outlined within the goals and objectives section of this plan.

The main parking area for visitors to the Punkhorn Parklands is located along Run Hill Road and Westgate Road to the north, Figure 4. The parking lot is gravel with a constrained entrance. Currently, it is difficult for firefighting apparatuses to enter the parking lot. Staging would likely occur on the road itself. Ingress and egress along Run Hill Road to the north will be difficult in areas with narrow road width and inadequate pull-offs for two-way traffic. The other main access point on the south side of Westgate Road at the Harwich town line provides adequate staging. The road is paved in Harwich with sufficient road shoulders for parking. There is a small interior parking area, off Westgate Road at the driveway to the Mattot House. This parking area was recently mulched and fenced off with split rail fencing and boulders to combat a problem with dumping of garbage. This area could be made accessible as a small staging area for firefighting apparatus with some minimal changes.

Several small roads and trails are closed to vehicular traffic and blocked with boulders, bollards, fences, or other barriers, Figure 4. Often the barriers such as boulders and bollards are ineffective at keeping out off road vehicles. Many of these barriers should be replaced with lockable gates, which will provide adequate access for firefighting personnel as well as deter illegal vehicular use. Department of Public Works Superintendent, Robert Bersin, has recommended closure of approximately 700 feet of East Gate Road, from the intersection with Punkhorn Road heading

north toward Pond Street to the southern most dwelling on East Gate Road in this vicinity. Should this road be closed to vehicular traffic, access should be maintained by lockable gates and road shoulder and overhead vegetation maintenance continued to ensure road edges do not close in.

There are a variety of trails throughout the Punkhorn Parklands. Many trails connect interior portions of the property and are part of a color-coded trail system, which is available on the Town of Brewster Web Site. Blue, yellow, green, and red trails may serve as firebreaks for low and moderate intensity prescribed fire but are unlikely to hold an intense wildfire.

GOALS, OBJECTIVES AND STRATEGIES FOR WILDLAND FIRE PREPAREDNESS

PRIMARY MANAGEMENT GOAL: Reduce wildfire hazards within the Punkhorn Parklands through an integrated and proactive land management program.

OBJECTIVES AND STRATEGIES:
Objective:

1. **Use prescribed burning and mechanical methods to reduce fuel loadings within priority fire-prone areas of the Punkhorn Parklands including:**

- **Firefighter and Public Safety Zones**
  Maintain reduced fuels within a 200-foot radius of major dirt road intersections and other designated locations with high hazard fuels. Areas of reduced fuels at road intersections will provide for public and firefighter safety by creating refuge areas where, in the event of wildfire, fire intensities will be less than experienced in surrounding (non-treated) areas. Road intersection reduced fuel zones will also provide a break in the fuel continuity offering advantageous areas to begin fire suppression actions. The following dirt roads intersections should be considered as Firefighter and Public Safety Zones.
  a) **Intersection Red Maple Road and Run Hill Road** consists of immature pitch pine stands and mixed oak - pitch pine forest with heavy understory and ladder fuels. Potential for torching into the pitch pine canopy. High priority for fuel reduction.
  b) **Entrance to Punkhorn Parklands and northern parking area** along Westgate Road/Run Hill Road consist of a gravel parking area surrounded by mixed oak and pitch pine forest, young pitch pine and greenbrier laddered fuels occur along portions of parking area and warrant fuel reduction.
  c) **Intersection Westgate Road and Eagle Point Cartway** consists of mixed oak – pitch pine forest with discontinuous shrub layer and scattered herbs. Pitch pine scattered throughout canopy. Low priority for fuel reduction at present time.
  d) **Intersection Westgate Road, Massasoit Trail, and Punkhorn Road** consists of mixed oak – pitch pine forest with continuous black huckleberry understory and some ladder fuels. Pitch pine cover increases to the east. Priority for fuel reduction.
  e) **Intersection Westgate Road, Mattot House Driveway, and Small Parking Area** consists of a small parking area, which is mulched and the opening fenced. It is surrounded by mixed oak – pitch pine forest. Maintain reduced fuel loads surrounding opening and replace fence with locked gate.
  f) **Intersection of Westgate Road and Black Duck Cartway** consists of mixed oak – pitch pine forest with dense pitch pine cover in some areas. Continuous huckleberry understory with ladder fuels. Priority for fuel reduction.
  g) **Intersection of Black Duck Cartway and Archie's Cartway** consists of mixed oak – pitch pine forest with continuous black huckleberry understory and some ladder fuels. Some dense stands of pitch pine at greater than 50% cover. Priority for fuel reduction.

h) **South entrance to Punkhorn Parklands at Westgate Road and Brewster/Harwich Town Line** consists of pitch pine forest with heavy pitch pine cover and continuous scrub oak and black huckleberry understory on both sides of road. High priority for fuel reduction. Efforts should be made to work with the Town of Harwich to reduce fuel loadings along road buffers here.

- **Residential and Wildland Interface Zones**
  Initially remove (break up) fuels and thereafter maintain reduced fuels within a 200-foot wide band along the residential and wildland interface. Widened zones of reduced fuels decrease wildfire intensity and allow for more effective fire control within these areas. Thereby, reducing the potential for wildfire to spread onto adjacent private land or minimizing the potential for fire starts on private land to spread rapidly onto the Punkhorn Parklands.
  -Priority areas include the wildland boundaries with the Deerfield Subdivision, residential areas east of Massasoit Road, inholdings along Westgate Road, and new housing developments along the Brewster/Harwich Town Line.

- **Interior Road Buffers**
  Maintain reduced fuels within a 100-foot buffer of both road shoulders on select roads within the Punkhorn Parklands. This will reduce the ignition potential along roads from accidental or malicious fire starts. The fuel reduced road buffer slows fire behavior, increases the potential for roads to serve as fire breaks and allows for more effective fire control.
  - Priority roads include Westgate Road, Black Duck Cartway, portions of Red Maple Road, portions of Old East Gate Road, Punkhorn road, portions of East Gate Road, and portions of Squantum Path.

Figure 5, features priority fuel reduction zones within the Punkhorn Parklands.

In certain areas, very high fuel loads and proximity to residences, such as the Deerfield Subdivision, may impose dangerous conditions for land managers to conduct prescribed burns safely and achieve ecological management objectives. To address this problem, mechanical cutting such as mowing the understory and selectively thinning pitch pine may be used to reduce fuel loads and create conditions more favorable for future prescribed burns or continued mechanical treatments. If mechanical treatments are used without prescribed fire, large woody material should be chipped, burned in brush piles, or removed from the site.

Strategies for fuel Reduction:

Fuel reduced zones or shaded fuel breaks are designed to alter both surface and crown fire behavior within a widened zone to allow suppression forces a higher probability of successfully attacking a wildland fire within the Punkhorn Parklands. There are two primary purposes for fuel treatments:

- Alter the surface fuels, by breaking up the horizontal continuity of those fuels and increasing the height to the base of the live crown, thereby lowering fire intensity and the probability of torching.
- Selectively thin and remove pines to space the crowns and reduce the threat of crown fires spreading within the tree canopy and the probability of long range spotting.

The mechanical, prescribed fire, and other manual strategies (or prescriptions) for creating fuel reduced zones or shaded fuelbreaks within the Punkhorn Parklands are outlined as follows.

1a. Combination Mowing and Prescribed Fire Treatments Recommended within Priority Fuel Reduction Zones

Reduce the stature and break up the horizontal continuity of flammable understory fuels such as black huckleberry and scrub oak using a combination of mowing and burning applied on a periodic basis to reduce the potential for high intensity, fast moving fires. Shrubs and vines should be maintained at a height of less than 1.5 - 2 feet in priority fuel reduction zones where shrublands have the potential to ignite canopy fires. Initially, mow 50% of the understory vegetation between trees using handheld brush cutters, 2-wheeled landscaping tractors, or pulled or mounted mowing equipment. (Use equipment that minimizes soil disturbance.) This initial mowing provides for more easily managed and safer prescribed burns within fuel reduced zones. Prescribed burns will consume downed fine fuels, further reduce the stature of shrubs, and likely kill sapling white pine and pitch pine.

Mowing and burning may be done in the growing or dormant season depending on ecological and logistical constraints. Late growing season treatments are preferred to more readily attain management objectives. Rhizomatous shrubs such as black huckleberry are more susceptible to damage from cutting or burning during the growing season. Shrubs will resprout with less vigor and reduced cover following growing season treatments. If summer burning is not feasible, scheduling a mowing treatment in the late growing season followed up by prescribed burning in the dormant season is recommended.

After completing the first mow/burn cycle, repeat the combination treatment two years later. Due to possible short-term accumulation of fuels resulting from initial burning efforts, prescription parameters for burning after the second mowing require tighter parameters, 10-hour fuel moistures between 7-10%, and preferably 8or 9%, to ensure woody fuels are consumed.

After the second round of combination treatments, areas may be prescribed burned on a maintenance schedule every 4 to 7 years depending on season of treatment and fire effects. The resultant forest looks similar to an over-stocked oak woodland with a size reduction of 1-hour and 10-hour flammable fuels. The oaks tend to semi-prune themselves, the shrub and herb layers are low in stature, the litter layer is reduced, and the organic layer remains intact. Surface fires do not have the ability to develop into crown fires. The resultant surface fire flame lengths will be less than four feet, even during extreme fire weather conditions.

1b. Mowing Treatments Recommended within Priority Fuel Reduction Zones

In certain areas, very high fuel loads and proximity to residences may warrant mowing rather than prescribed fire treatments. Black huckleberry, scrub oak and other combustible shrubs and vines should be mowed to maintain a height of less than 1.5 feet in priority fuel reduction zones. The objective of mowing is to reduce the height of the shrub layer by 60 – 70 % and break up the horizontal continuity of understory fuels, thereby reducing the potential for high intensity, fast moving fires.

Targeting the most flammable understory vegetation for mowing or cutting – the black huckleberry, scrub oak, greenbrier, scattered low white pines, invasive vines etc. is a somewhat “modified mowing approach”. Leaving small islands of less flammable vegetation around oaks, other hardwoods, and well-spaced pines creates a mosaic rather than clearly defined swaths and results in less than 100% of the understory being removed.

Mowing can be accomplished at large scales (greater than one acre) using tractor-pulled brush-hogs, Davco rotary brush-mowers mounted on rubber-tracked vehicles or other mowing

equipment to cut shrubs and young saplings. Equipment should be capable of removing vegetation with diameters up to three inches. Use of equipment that minimizes soil disturbance is recommended. At smaller scales, such as around oak and pine trees, mowing can be accomplished using a Gravely or DR walk behind mower or chain saws, power brush cutters or brush saws. Mowing may be done in the growing or dormant season depending on logistical constraints. Late growing season mowing is recommended to more readily attain management objectives. Rhizomatous shrubs, such as black huckleberry, will resprout with less vigor and reduced cover after growing season treatments.
Maintenance mowing should occur every 3 – 7 years. The season and frequency of mowing may shift based on ecological and logistical evaluations of the initial treatments. The sustained alteration of fire behavior within these shaded fuel breaks requires effective and periodic maintenance mowing. Standards for maintenance mowing are as important as the initial prescription for creation of fuel reduced zones.

1c. Selective Forestry Operations Recommended within Priority Fuel Reduction Zones
Pitch pine should be thinned within priority fuel reduction zones to reduce the potential for torching and the threat of crown fires in the tree canopy. Crown fires are more difficult to control than surface fires. They have higher rates of spread and longer flame lengths. Frequent spotting from crown fires can occur over longer distances. The increased spotting and radiant heat from crown fires make structures more difficult to defend and dictate larger safety zones within the wildland-urban interface (Scott and Reinhardt 2001, Patterson and Crary 2004).

Maintain wider spacing between pine trees to reduce the potential for fire to spread in the tree canopy. Selectively thin and remove pines within priority buffer areas. Pine crowns should not touch or over lap, and the overall pine canopy should be less than 50% cover. Maintaining a conifer basal area of less than 40 ft^2 /acre will significantly reduce the potential for canopy fires. Very high wind speeds would be needed to sustain a crown fire in a more open pine canopy (Patterson and Crary 2004). Trees should be cut at ground level and logs removed. Slash should be removed, chipped or burned in brush piles within a timely manner so as not to contribute to the fuel loading on site.

In addition, pruning the lower branches of the remaining pine trees within designated areas can reduce the potential for fire to move into the canopy. Branches less than 8 feet high should be removed. Understory white pine (often between 6 and 15 feet high) should be cut and removed within priority fuel reduction zones. Logging, landscaping and backyard debris piles within these priority areas should also be removed or burned.

1d. Recommendations for Control of Invasive Vines within Priority Fuel Reduction Zones
Invasive vines such as oriental bittersweet are found blanketing the ground and climbing trees and shrubs along forest edges and other disturbed sites. These invasive vines create fuel ladders of continuous fine material from the forest floor to the tops of trees and increase the potential for crown fires. Dense infestations also make trees top heavy and more vulnerable to wind damage.

Mowing, cutting of stems, and pulling vines from trees will control vines and reduce the potential for fire reaching the tree canopy within priority interface zones, interior roads, and firefighter and public safety zones. Repeated mowing and cutting will contain the vines but not likely eradicate them. Periodic mowing and cutting in the late growing season is likely most effective. Vines such as bittersweet and porcelain berry are prolific seeders and are also able to reproduce readily from stems and roots. Small plants may be dug out and removed. When working in larger infestations, it is advantageous to bag and remove material from site after cutting and pulling.

The shaded fuel break width and treatment strategies recommended for the Punkhorn Parklands are based on assessment of existing vegetation/fuels and empirical data from fuels demonstration sites at Montague Plains, Martha's Vineyard State Forest, and Cape Cod National Seashore. Applied research sponsored by the National Joint Fire Science Program, underway at these three Massachusetts sites, has documented the effects of mechanical and prescribed fire treatments on fuel loads and fire behavior characteristics. Based on radiant heat loads for volatile shrubland fuels such as black huckleberry, widths at least 200 feet (65 meters) are recommended for safety considerations within the Punkhorn Parklands. This is the shaded fuel break width recommended for interior roads (100 ft. buffer both sides), firefighter and public safety zones (200 ft. radius), and wildland – urban interface zones (200 ft. buffer).

1e. Recommendations for stacking and burning brush piles

Recommended brush pile size is 4 feet wide, six feet high, and 8 feet long. As much as two feet may settle before burning. Piles can be made bigger and settle to the approximate final size of 4x4x8 feet. Piles should be comprised of materials no longer than 4 feet in length. 4-foot length materials allow for easy rearrangement whenever necessary, especially during burning. Piles should be compact but not compressed. Piles comprised largely of deciduous materials need to be compact. If larger logs are piled, they should be arranged in a cris-cross crib fashion with smaller material piled within. Piles should have a water barrier inserted within the length of the interior while they are being made. Recommended water barriers include long sheets of waxed paper or sheet plywood. If heavy snows are expected additional covering should be made on top of piles.

In general, live material greater than 6 inches in diameter should not be piled, as it is not likely to burn within same burning season. For example, if piles are made in the summer and fall and are expected to burn in January through May, the larger diameter material will not burn. Piles that remain dry and covered may have up to 20% live material, 6-10 inches in diameter, in the pile. Dead material up to 10 inches in diameter may be added to piles if kept dry. Punky material that absorbs atmospheric moisture should not be added to piles. If it must be added, it should remain up high in the pile and covered, whenever possible.

Ignition of brush piles can be made with drip torch or fusee. Drip torch is recommended. Leaf blowers or other wind generating devices (compressed air or fans) used during burning activities are recommended to increase consumption of pile materials. Leaf blowers used in burning brush piles at Cape Cod National Seashore increased consumption of materials up to 400% and left limited to no charred leftovers (David Crary Jr., personal communication). Blowers also lessen the amount of smoke generated during burning, as combustion is more complete. It is imperative to note that leaf blowers should only be used when weather conditions limit spotting potential, such as high relative humidity during the fall/winter/spring, or during periods of fog, light precipitation, or when snow is on the ground.

Brush piles should be located away from power lines and other overhead improvements. Piles with copious amounts of fine pine fuels may exhibit flame lengths of 20 feet or more. Leaf blowers will help reduce the height of flames.

An active plan for creating and burning brush piles should consider making piles throughout the spring, summer, and fall and burning throughout the winter months. Piles can be burned when conditions are moist to wet if leaf blowers are utilized. Leaf blowers provide for greater consumption of materials and allow workers to cut and add more materials, 4 inch or less in diameter, to the pile during burning activities.

Objective:

2. **Maintain the integrity of dirt roads and access points to provide for rapid response, fire suppression, and fire breaks.**

- **Maintain cleared width of interior dirt roads to original embankments.**
  The main dirt roads within the Punkhorn Parklands should be periodically brushed, mowed, and tree removal maintained. Shrubs and saplings should be brushed back to eliminate overhang into cleared passages. The minimum pruned height of tree branches along passageways should be 10 feet. Debris should be piled and burned or chipped and removed as soon as possible. In some cases it may be necessary or desirable to remove debris from the project area. All stumps within the roadway and along embankments should be cut flush with the ground. Although smaller roads, such as Old East Gate Road, do not provide access for large firefighting apparatuses, they are still accessible to forestry trucks with slip-on units and should also be maintained for prescribed fire and suppression activities. There is a build up of dried heavy fuels along the sides of Punkhorn Road, just southeast of the boundary with the Punkhorn Parklands. Work with the private landowner to remove brush and other debris from this area.

- **Dirt roads should be periodically inspected for soil compaction, erosion, and on-going vegetation management.** Repairs on roads are imperative to provide for rapid response and fire suppression. Conduct annual on-site meetings to evaluate the integrity of the road network. Participants should include staff from Department of Natural Resources and Conservation, Department of Public Works, Brewster Fire and Rescue Department and Brewster Water Department.
  - Maintaining good road conditions on major access roads such as Westgate Road, Black Duck Cartway, and Run Hill Road is imperative.
  - Evaluate and determine need for filling and/or grading washouts, gullies, and dips in roads to avoid impaired road surfaces, particularly along portions of East Gate Road, Squantum Path, Old East Gate Road, and Punkhorn Road.

- **Maintain access points and gates into the Punkhorn Parklands. A**ccess points and gates on roads should be checked regularly to ensure adequate access, closure, and drivability. At times, illegal dumping of yard waste and other trash items block access points onto and within the property. Fences, boulders, ineffective bollards and private locked gates also limit access in some key areas and should be replaced with appropriate locked gates.
  - Maintain adequate access along the north and south entry points to Westgate Road.
  - Evaluate the need for additional road pull-offs on Run Hill Road to accommodate access and egress during emergency situations.
  - Evaluate need for improvements along short narrow corner of Black Duck Cartway near intersection with Cranview Road to allow access for firefighting apparatuses.
  - Evaluate access issues along portions of East Gate Road and need for locked gates on Town –owned property.
  - Evaluate locked private gates on Massasoit Trail and Cranview Road and seek cooperative agreements to ensure any gates meet access/egress specifications for firefighter access and locks are nested for appropriate use.
  - Remove boulders, ineffective bollards, and fences and replace with locked gates in appropriate places. Priority areas for consideration include Seymour Pond Trail, Francis Way, small road paralleling Westgate Road along the Brewster/Harwich town line, and Quarry Road.
  - Replace split rail fence at interior parking area with locked gate and guardrail.

- **Maintain road signs and adequate maps to provide for rapid response.**

Objective:

3. **Provide neighboring landowners with information regarding fire hazards and recommendations to protect life and property from wildfire.**

- **The Town of Brewster may wish to consider the development and adoption of applicable FIREWISE Standards for dwellings and other structures, fuel storage, and vegetation around dwellings within and adjacent to the Punkhorn Parklands.**
  Developing and adopting applicable FIREWISE Standards will help to reduce the susceptibility of homes, communities, and other structures to wildfire through cooperative education and mitigation techniques. FIREWISE is a multi-organizational initiative sponsored by the National Wildfire Coordinating Group's Wildland/Urban Interface Working Team. The initiative is designed to work with concerned citizens, local fire departments, state forestry staff, public land managers, and other fire safety professionals to lessen the risk of interface fires through education, prevention, and supportive mutual effort. For more information about FIREWISE, visit www.firewise.org.

- **Conduct a series of informational workshops at the Brewster Fire and Rescue Station regarding Firewise Standards for private landowners within residential inholdings and adjacent residential developments, such as the Deerfield Subdivision.**
  Cooperative education and mitigation workshops will help reduce the susceptibility of homes and structures to wildfire and lessen the overall risk of interface fires. These workshops will also help landowners stay more informed and better understand on-going management activities within the Punkhorn Parklands.

  Firewise techniques that homeowners and communities utilize may include minimizing the risk of home ignition by carefully landscaping around residential structures, such as thinning trees and brush, removing ladder fuels and choosing fire-resistant plants; selecting ignition–resistant building materials; positioning structures away from slopes; keeping critical access points open; and working with firefighters and other fire management teams to develop emergency plans. Appendix A includes *A Homeowner's Guide to Wildfire Retrofit,* a pertinent national FIREWISE and Institute for Business and Home Safety publication that provides citizens with information necessary to maintain an acceptable level of fire readiness.
  - Seek voluntary cooperation of private landowners to implement fuel reduction strategies to ensure that critical boundaries with private lands and the Punkhorn Parklands are defensible. Priority areas include the Deerfield Subdivision, Westgate Road Residential Inholdings, private residences along Black Duck Cartway, Archie's Cartway Residential Inholdings, the new subdivision along the Brewster/Harwich line near Squantum Path, and residential areas east of Tucker's Pond.
  - Provide incentives for private landowners in priority wildland-residential interface areas to reduce hazardous fuels on a periodic basis by providing slash pick-up and disposal days sponsored by the locality.
  - Reduce hazardous fuel loads around the town-owned Mattot House and consider its use as a demonstration site for FIREWISE standards within the area.

Objective:

4. **Employ best management practices during the course of vegetation management to maintain and enhance biological diversity in varying seral stages of the vegetation.**

- **Determine the status of rare species within the Punkhorn Parklands and develop monitoring and management protocols for long-term maintenance.** Work with the Massachusetts Natural Heritage and Endangered Species Program and local biologists to monitor and determine the current status of rare plants and animals found within the area. Develop management protocols that protect sensitive resources on the property. Several rare species are found in fire-adapted communities and are likely to respond favorably to carefully planned prescribed fire management and mechanical treatments carried out within appropriate seasons and rotations. Known populations of rare species should be identified and flagged when fuel reduction treatments are proposed for specific areas to avoid trampling and/or compaction by equipment.

- **Avoid soil disturbance activities in maintaining fuel-reduced zones within forests.** Areas of extensive soil disturbance tend to generate a proliferation of weedy species and pitch pine. Tree removal and mechanical cutting should be done with equipment that minimizes soil scarification.
  - Monitor the newly created road to test well site south of Boot Swamp to ensure pitch pine does not become established. Remove pine seedlings and cut young pines on a periodic basis.

- **Consider cutting and removal of young pitch pine thickets.** Remove the high-density immature pitch pine stands, which have established on disturbed soils in the vicinity of the Deerfield Subdivision and Punkhorn Parklands. Strategies may include cutting, piling, and burning pines in these areas. Then using a combination of prescribed fire and cutting to eliminate more pines from this area. The value of native vegetation will be enhanced if vigorous young conifers are eliminated from crowding out native species and fire hazards will be greatly reduced.

- **Utilize prescribed fire, whenever possible, to encourage regeneration of native oak species and maintain fire adapted mixed oak – pitch pine forests.** Prescribed fire most closely replicates the natural disturbance regime of these forests and eliminates more fine fuels from the area than large-scale mechanical treatments. There is a tremendous value in creating and maintaining forest stands of different age, structure, and dominance to increase biological diversity within the area. This plan suggests burning small interior forested tracts after protection of priority fuel reduction zones in residential/wildland interface zones, public/firefighter safety zones, and road enhanced buffer zones through mechanical and prescribed fire treatments. Low intensity prescribed burns on a 7-10 year management cycle are recommended for small interior forested units, 10 acres or less. A trained crew with the appropriate support equipment could easily manage small units. Small triangular units in the vicinity of Westgate Road, Massasoit Trail, Seymour Pond Trail, and Punkhorn Road should be considered and would provide ideal pilot sites for prescribed fire, break up the continuity of fuels within the central portion of the property, and protect critical resources to the north.

- **Consider control of select non-native plants, such as Oriental bittersweet from forest - residential ecotones and common reed grass from wetland areas.** Removal of certain invasive non-native plants such as Oriental bittersweet will require aggressive treatments utilizing a combination of cutting and other techniques. Materials may be cut, piled, and burned or removed from site. Then followed up with prescribed fire management or mowing treatments, every two to three years. It is likely that selective treatment with an

environmentally approved herbicide will be necessary to reduce and control species such as common reed grass. Reclamation of these areas is generally costly and time consuming, requiring careful planning and execution.

- A potential pilot project would involve the removal and control of a small stand of common reed south of water treatment facility. This invasive plant produces lots of cured and flashy fuels, which pose a fire hazard to surrounding areas within the Punkhorn. Removal of this plant will also increase plant diversity in the area. It is likely that selective treatment of individual stems with an environmentally approved herbicide will be necessary to reduce and control common reed. This stand of invasive grass lies within the control perimeter of the Brewster water treatment plant and well site and would require stringent precautions.
- As management decisions regarding the control of invasive species can be very difficult, mapping the distribution and monitoring the status of invasive plants such as common reed within the Punkhorn Parkland will help determine whether these species are highly invasive. As well as help determine whether they are desirable or undesirable from an ecological and socioeconomic perspective.

- **Establish monitoring protocols to determine the effectiveness of fuel reduction management treatments and long-term trends within mixed oak – pitch pine forest and other forested communities.**
  Seek services of a forester, botanist or ecologist to conduct the monitoring associated with assessing treatments in maintaining shaded fuel breaks. This individual may design monitoring protocols, conduct the work and summarize data efficiently. The uses of boards or poles used to index the structural density of vegetation are useful along with photo plots and other techniques in assessing treatment efficacy at low cost.

Objective:

5. Offer prescribed burn training opportunities on these properties, emphasizing basic wildland fire behavior, fire suppression, ignition techniques, and safety procedures.

Opportunities to apply prescriptive fire on the landscape are limited because of public safety and smoke management concerns. Use of prescribed fire to reduce wildfire hazards and maintain valued landscape features is still a viable option for interior portions of the Punkhorn Parklands. Given the network of interior dirt roads and vegetation units, the area provides excellent opportunities for training in basic wildland fire behavior, fire suppression, ignition techniques, and safety procedures for local fire personnel as well as conservation, public works, and natural resource personnel for the Town of Brewster. Seek cooperative agreements with other public agencies, such as The National Park Service to assist with prescribed fire activities.

Objective:

6. Develop prescriptions for priority fuel reduction zones and other management units.

Areas proposed for prescribed fire treatment and mechanical treatment require careful planning and execution. Seek services of qualified fire planner in developing burn prescriptions.

- **Prescribed burns should only be conducted in accordance with approved prescribed burn plans.** The prescribed burn plan is the field document that sets forth the details for conducting a particular burn treatment on a particular burn unit. It provides specific ecological and technical information to guide the fire leader or prescribed burn boss. The plan should include objectives to accomplish a particular burn, as well as an acceptable range of fire weather, fuel moisture, and fire behavior parameters to safely achieve desired effects. Burn specific information on hazards, sensitive resources, and smoke sensitive areas are also addressed. The plan describes ignition, holding, and mop-up activities. Defines personnel and equipment needed and outlines safety and contingency plans.

- **Permission must be obtained prior to burning from the Brewster Fire and Rescue Department.**

- **The Town of Brewster (with the assistance of a prescribed fire planner or fire leader) must request a permit under the Air Pollution Control Regulations to conduct prescribed burns on the Punkhorn Parklands from the Bureau of Waste Prevention, Compliance and Enforcement Section of the Southeast Regional Office of the Department of Environmental Protection.**

- **The Town of Brewster Conservation Administrator or personnel from the Brewster Fire and Rescue Department should coordinate public notification and public awareness efforts related to prescribed burns and mechanical treatments.** Informed citizens, with an understanding of ongoing management activities, will usually be supportive of land management and wildfire protection efforts.

- **Seek services of qualified fire leaders to conduct prescribed fire activities.** A list of qualified fire leaders/prescribed burn bosses who are currently active (2006) in Massachusetts is included in Appendix B.

Objective:

7. Establish team of land managers and fire professionals for Punkhorn Parklands to determine implementation schedule and guide management actions. All recommendations outlined in this plan cannot be implemented immediately. Limitations of technical resources, sequencing of actions, and limited funding resources require that priorities be established. Those actions deemed most critical to reducing very hazardous fuel loads and providing for public safety should be addressed first.

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APPENDIX A

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APPENDIX B

QUALIFIED FIRE LEADERS (A list of qualified fire leaders/prescribed burn bosses who are currently (2006) active in burning in southeastern Massachusetts)

Name/Affiliation: David W. Crary Jr., Fire Management Officer
Cape Cod National Seashore
Address: National Park Service
99 Marconi Site Road
South Wellfleet, MA 02663
Telephone: 508 349-3785 x 247

Name/Affiliation: Jeff Bouschor, Engine Supervisor
Cape Cod National Seashore
Address: National Park Service
99 Marconi Site Road
South Wellfleet, MA 02663
Telephone: 508 349-3785 x 243

Name/Affiliation: Joel Carlson, Consulting Fire Manager
University of Massachusetts/Amherst
Address: 29 Moody Drive
Sandwich, MA 02563
Telephone:

Name/Affiliation: William A. Patterson III, Fire Ecologist/Professor
Address: University of Massachusetts
Department of Forestry and Wildlife Management
Amherst, MA 01003
Telephone: 413 545-1970

Name/Affiliation: Tim Simmons, Restoration Ecologist
Massachusetts Division of Fisheries and Wildlife
Address: Natural Heritage & Endangered Species Program
Route 135
Westborough, MA 01581
Telephone: 508 792-7270 x 126

Name/Affiliation: Acting Chief Fire Warden
Massachusetts Department of Conservation and Recreation
Bureau of Fire Control
Main contact for qualified DCR personnel
Address:

APPENDIX C

GLOSSARY OF TERMS

Basal Area – a measure, similar to cover, being the proportion of ground surface occupied by a species.

BEHAVE Fire Modeling System - a software application to predict wildland fire behavior for fire management purposes.

Canopy Closure – the distance between the tree tops if one were to look straight up. If the canopy closure is very dense, then the spacing is very tight with very little sunlight able to pass through.

Chain – a unit of measure in land survey and forestry, equal to 66 feet (20 meters). Commonly used to report fire perimeters, fireline distances, and rates of spread.

Cover – the vertical projection of above ground parts onto the ground. Ecologists recognize many types of cover: crown cover, vegetative cover, ground cover, forest cover etc.

Crown Fire – a fire that advances from top to top of trees or shrubs more or less independently of the surface fire. Sometimes crown fires are classed as either running or dependent, to distinguish the degree of independence from the surface fire.

Defensible Space – a designated area around a home or building that is intentionally maintained so as to be free of any features that would tend to increase the risk of damage from wildfire.

Density – the number of individuals per unit area.

Density Board – a post or board used to measure cover and height of vegetation by obstruction to vision.

Drought Index – a number representing net effect of evaporation, transpiration, and precipitation in producing cumulative moisture depletion in deep duff or upper slope soils. The Keetch-Byram Drought Index (KBDI) is used in fire planning to evaluate the effects of extended drying on the duff layer. More information on KBDI is available from http://flame.fl-dof.com/fire weather/info/kbdi/

Duff – the partly decomposed organic material sandwiched between the litter of freshly fallen twigs, needles, and leaves and the mineral topsoil.

Fine Fuels – small diameter fuels such as grass, leaves, draped pine needles, and twigs, which when dry, ignite readily and are rapidly consumed.

Fire Behavior – the manner in which fire reacts to the variables of fuel, weather, and topography.

Fire Danger – resultant of both constant and variable fire danger factors, which affect the ignition, spread, and difficulty of control of fires and damage they cause.

Fire Frequency – the number of fires per unit time in a designated area.

Fire Intensity – generally refers to flame length and rates of spread in surface fires. High intensity fires have long flame lengths and high rates of spread but may not burn down into the litter and duff layers.

Fire Severity – generally refers to fire burning into the litter and duff layers, associated with certain surface fires or ground fires. Severe fires occur when temperatures are high and humidity and precipitation are low for long periods of time, duff and litter dry out and fire can reside for long periods of time, resulting in reduction or loss of organic material down to mineral layers.

Fireline Intensity – the heat released per unit of time for each unit length of the leading fire edge. The primary unit is Btu per linear foot of fire front per second.

FIREWISE – a multi-organizational initiative sponsored by the National Wildfire Coordinating Group's Wildland/Urban Interface Working Team. An initiative designed to work with concerned citizens, local fire departments, public land managers, and other fire safety professionals to lessen the risk of interface fires through education, prevention, and supportive mutual aid. (www.firewise.org)

Flame Length – the average length of flames when the fire has reached its full, forward rate of spread, measured along the slant of the flame from the midpoint of its base to its tip.

Fuel – combustible plant material, both living and dead that is capable of burning in a wildland situation.

Fuel Arrangement – the spatial distribution and orientation of fuel particles within the fuel bed.

Fuel Bed Depth – the average height of surface fuels contained in the combustion zone of a spreading fire front.

Fuel Continuity – the degree or extent of continuous or uninterrupted distribution of fuel particles in a fuel bed, a critical influence on a fire's ability to sustain combustion and spread. This applies both to aerial fuels and surface fuels.

Fuel Model – a characterization of the fuel properties within a typical field situation. Sets of standardized fuel models are available from the USDA Forest Service for fire behavior and fire spread modeling. (www.fs.fed.us/pnw/fera/firehouse)

Fuel Moisture Content – the quantity of moisture in a fuel expressed as a percentage of the weight when thoroughly dried at 212^0 F.

Fuel Reduction Zone – any area, strategically located for fighting anticipated fires, where the vegetation has been periodically modified or treated so that fires burning into it can be more easily controlled. Widened zones of reduced fuels decrease wildfire intensity and allow for more effective fire control.

Fuel Size Class – a category used to describe the diameter of down dead woody fuels. Fuels within the same size class are assumed to have similar wetting and drying properties, and to preheat and ignite at similar rates during the combustion process.

Ground Fire – a fire that consumes the organic material beneath the surface litter, such as a duff fire or a peat fire.

Ground Fuels – all combustible materials below the surface litter layer, including duff, tree and shrub roots, punky wood, dead lower moss and lichen layers, and sawdust, that normally support glowing combustion without flame.

Head Fire – a fire spreading or set to spread with the wind.

Hundred Hour Time Lag Fuels – dead fuels consisting of roundwood in the size range from 1 – 3 inches in diameter, estimated to reach 63% of equilibrium moisture content in one hundred hours.

Invasive Non-native Plant – a plant that exhibits rapid growth and out competes native plant species, thereby reducing species diversity. Not all non-native plants are invasive.

Ladder Fuels – any materials which allow fire to move vertically from the ground up to the tops of trees (e.g. dead fuels to lower branches to other intermediate trees and shrubs to the upper tree canopies).

Litter – loose debris such as leaves, branches, twigs, logs laying on the surface of the ground.

One-Hour Time Lag Fuels – dead fuels consisting of dead herbaceous plant materials, sticks, needles and roundwood less than 0.25 inches in diameter, expected to reach 63% of equilibrium moisture content in one hour or less.

National Fire Danger Rating System – a multiple index designed to provide fire and land management personnel with a systematic way of assessing various aspects of fire danger on a day-to-day basis.

Prescribed Burning – controlled application of fire to wildland fuels under specified environmental conditions that allows the fire to be confined to a predetermined area, and produce the fire behavior and fire characteristics required to attain planned fire treatment and resource management objectives.

Prescription – a written statement defining the objectives to be attained as well as the conditions of temperature, humidity, wind direction and speed, fuel moisture, and soil moisture, under which a fire will be allowed to burn.

Rate of Spread – the speed with which a fire moves in a horizontal direction across the landscape, usually expressed in chains per hour or feet per minute.

Relative Humidity – the ratio, in percent, of the amount of moisture in a volume of air to the total amount which that volume can hold at the given temperature and atmospheric pressure.

Slash – the remnants of tree limbing, thinning, and ground fuel reduction. May also be resultant from strong winds. Composed of branches, tops, cull logs, uprooted stumps, and broken or uprooted trees.

Spotting – production of burning embers in the mowing fire front that are carried a short distance ahead of the fire, or in some cases are lofted by convective action or carried by fire whirls some distance ahead of the fire.

Surface Area to Volume Ratio (SAV) – the ratio between the surface area of an object, such as a fuel particle to its volume. The smaller the particle, the more quickly it can become wet, dry out, or become heated to combustion temperature during a fire.

Surface Fire – a fire that burns surface litter, other loose debris, and low vegetation.

Ten-Hour Time Lag Fuels – dead fuels consisting of wood, 0.25 – 1 inch in diameter, estimated to reach 63% of equilibrium moisture content in ten hours.

Thousand-Hour Time Lag Fuels – dead fuels consisting of roundwood 3 – 8 inches in diameter, estimated to reach 63% of equilibrium moisture content in one thousand hours.

Wildfire – any fire occurring on wildland except a fire under prescription.

Wildland – an area characterized predominantly by native vegetation, in which development is essentially non-existent, except for roads, powerlines and similar facilities.

Wildland – Residential (or Urban) Interface – the area where combustible homes and other structures meet combustible vegetation. This interface may include a wide variety of situations, ranging from individual houses and isolated structures to subdivisions and rural communities surrounded by wildlands.